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A systematic study of NLTE abundances of nearby stars

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Abstract. Approximately 80 stars from the thin disk, the thick disk and the halo of the Galaxy, in the range of $-3.0 < [Fe/H] < +0.5$, surface gravity of $3.0 < logg < 4.7$ and temperature of $4500K < Teff < 6500K$, have been observed with the Shane/Hamilton and CFHT/Espadons spectrographs in order to carry out a systematic NLTE study of nearby stars in a consistent way. We will determine reliably stellar parameters and determine precise elemental abundances via a comprehensive NLTE analysis of the spectral lines of Li, Na, Mg, Al, Si, K, Ca, Sc, Mn, Fe, Sr, Zr, Ba, Nd, and Eu elements. Finally, we aim to investigate the chemical evolution of the Galaxy through different stellar populations based on the NLTE abundances for total 15 elements.

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An integral part of the Galaxy history is the chemical evolution of the Galaxy that is recorded in the chemical composition of un-evolved cool stars. Stellar abundance trends establish important observational constraints on models of nucleosynthesis and the chemical evolution of the Galaxy (e.g. the milestone paper of McWilliam *et al.* 1995). Still today, the vast majority of abundance analysis of late-type stars relies on the assumption of local thermodynamic equilibrium (LTE). It is expected that this approach quite often gives misleading results, and for many elements such systematic errors may be very severe.

A systematic investigation on the NLTE abundance analysis for F&G-type stars in a homogeneous way as is presented here seems worthwhile and timely. This special study is of high significance at least in two ways. Firstly, the ratios of [α/Fe] can be more accurately derived by performing the NLTE analysis of both alpha elements (Mg, Ca, S, etc) and iron (FeI and FeII) abundances. It is well known that [α/Fe] ratio is the most important indicator for distinguishing abundance patterns of different chemical enrichment patterns among different populations of the Galaxy and between the Galaxy and nearby dwarf galaxies. Secondly, the exact extent of FeI/FeII deviation as a function of metallicity is still in dispute and any consensus has not been accomplished (e.g., Shchukina *et al.* 2005 argued considerably large NLTE correction amounting to $0.6 - 0.9$ dex). Obviously, the investigation of FeI/FeII non-LTE equilibrium from both the observational and the theoretical side are important in order to settle the controversy and is of substantial importance in the galactic chemical evolution study, since it might as well impose a drastic revision in the [Fe/H] scale of very metal-deficient stars.

References

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